люминесценции ионов Er^{3+} в K_2YF_5 с учетом поляризации света.

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1. An ab initio density functional theory calculations on the K_2YF_5 crystal containing hydroxyl impurities / A.A. Gallegos-Cuellar, R. Licona-Ibarra, J.F. Rivas-Silva, A. Flores-Riveros, J. Azorin Nieto, J.F. Casco-Vásquez // Journal of Molecular Structure. – 2013. – V. 1051 – P. 177 – 179

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LASER PHOTOTHERMOACOUSTIC MICROSCOPY VERIFICATION

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New possibilities are opened towards original highly sensitive nondestructive testing method – laser photothermoacoustic microscopy (LPTAM), based on applied physical multigraded principles of faint signals excitation, registration and processing with posterior extraction of useful information concerning permanent connections internal structure with macro-, micro- and sub micro- resolution. On account of high sensitivity to a continuity violation of aforesaid permanent connections the most difficult problem of this method future commissioning lies in the fact of output data verification. Considering complication of measuring body sampling in the range of maximal sensitivity to the continuity violation this method verification was successfully carried out by the means of destructive inspections, intercomparison of alternative nondestructive methods and statistical comparison based on a correlation analysis.

*A. **The specificity and reliability of this diagnostic multistage technique***

In the course of inspection performed on microbonded connections (fig. 1) was caught essentially different sight of the resultant laser photoacoustic topograms (fig. 2, 3) of two extreme kinds: unsatisfactory (fig. 2) and satisfactory connection quality (fig. 3).

The laser photoacoustic topogram (fig. 3) was resulted at the highest possible gain factor authenticated by background noise what vindicate the specificity and reliability of this diagnostic multistage technique. Besides background noise and configuration of the microbonded wire connection one can see island regions of aluminum oxide shut in films coloured in turquoise.

Figure 1 – Typical exterior view of the ultrasonic microbonded wire connection

The similar LPTAM check experiment was conducted on the imperfection specially created in the soldering paste die assembly layer of semiconductor chip #4 of the semiconductor device in order to provide congruence relative to the perfect mounted concomitant semiconductor chip #3 (Fig. 4).

Figure 2 – Laser photoacoustic topograms of unsatisfactory connection quality (spatial X, Y resolution – 2.5 μm)

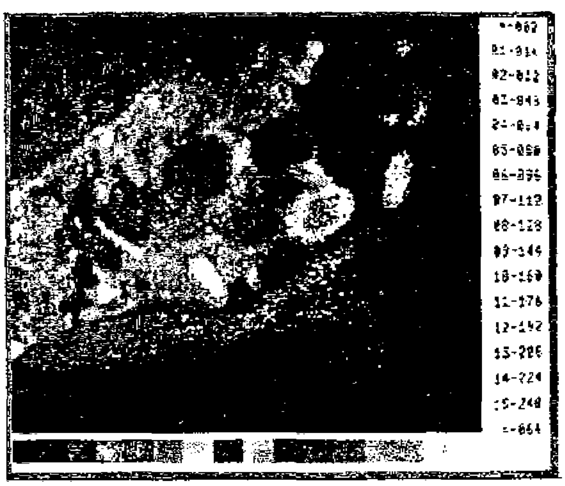

Figure 3 – Laser photoacoustic topograms of satisfactory (rotated) connection quality (spatial X, Y resolution – 2.5 μm)

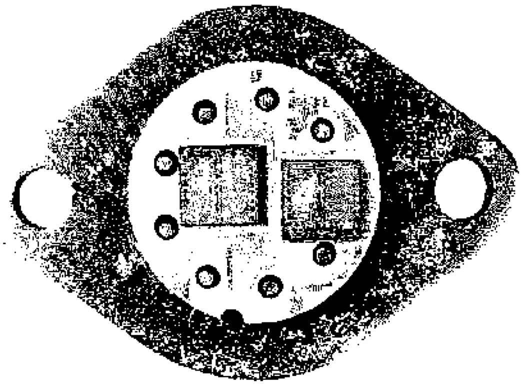

Figure 4 – Exterior view of the semiconductor device with perfect mounted semiconductor chip #3 and concomitant semiconductor chip #4 with the imperfection specially created in the soldering paste die assembly layer

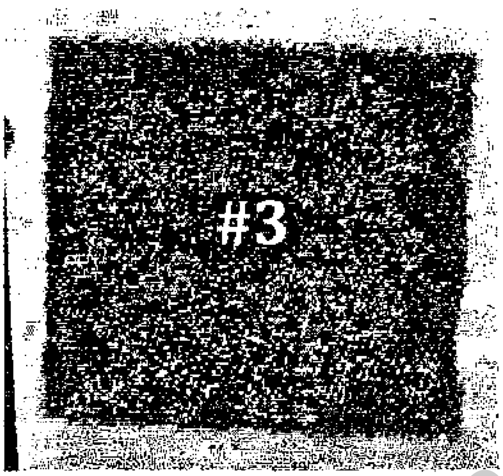

Figure 5 – Laser photoacoustic topograms resulted at the highest possible gain factor of perfect mounted semiconductor chip #3 and concomitant semiconductor chip #4 with the imperfection specially created in the soldering paste die assembly layer (spatial X, Y resolution – 50 μm)

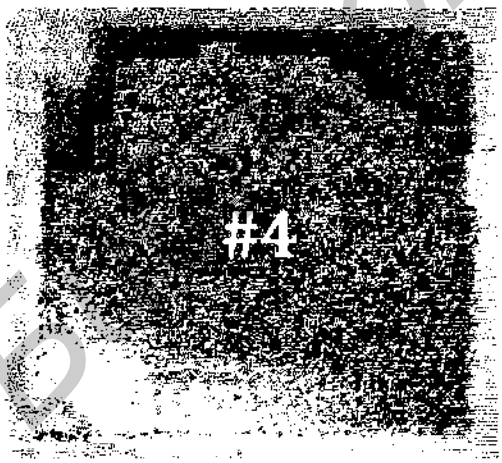

Figure 6 – Laser photoacoustic topograms resulted at the highest possible gain factor of concomitant semiconductor chip #4 with the imperfection specially created in the soldering paste die assembly layer (spatial X, Y resolution – 50 μm)

The laser photoacoustic topograms (fig. 5, 6) were resulted at the highest possible gain factor and show the perfect mounted semiconductor chip #3 equal to mounted semiconductor chip #3 shown on fig. 4 what was improbable before previous experience by means of antiquated methods application such as eutectic and solder compositions. In order to provide experimental verification of the chip #3 perfect mounting the replicate chip #4 equal to mounted semiconductor chip #4 shown on fig. 4 was mounted with the imperfections in the soldering paste die assembly layer.

As an example of direct comparison the bonding die of semiconductor device using adhesive low-quality compositions are shown on fig. 7, 8.

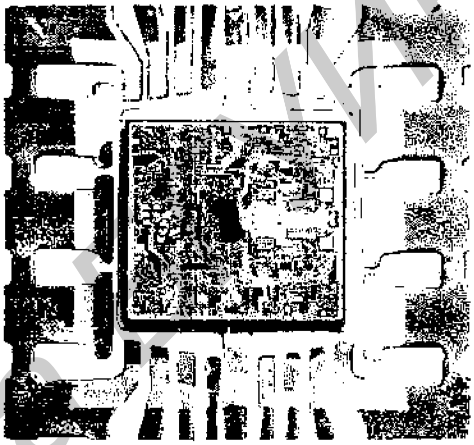

Figure 7 – Exterior view of the semiconductor device with low-quality adhesive mounted semiconductor chip

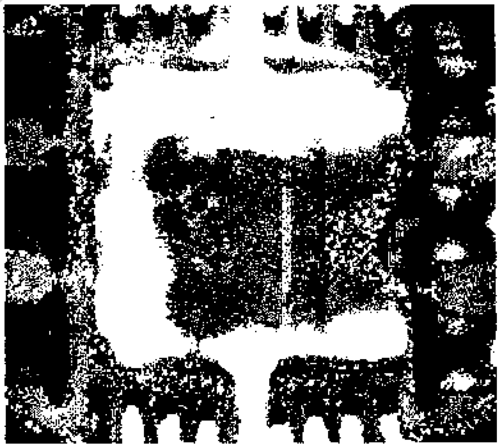

Figure 8 – Laser photoacoustic topogram of the semiconductor device with low-quality adhesive mounted semiconductor chip resulted at the low gain factor (spatial X, Y resolution – 50 μm)

The laser photoacoustic topogram (fig. 8) visualize low adhesion of glued joint "die - lead frame pad" almost on 90% of chip mounting surface area.

1 Волкенштейн С.С., Хмыль А.А. Неразрушающие методы контроля качества монтажа полупроводниковых кристаллов в корпуса ИМС «Технологии в электронной промышленности», №2, 2011 г., с. 18-22